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It should be stated, however, that it is by no means certain that the problem referred to in the letter is No. XLVI of the second edition of the *Doctrine of Chances.* It may be some other problem to which we have no certain way of attaching Stevens's name.

Coming now to the letter itself, it seems that the problem was given to De Moivre by Stevens about 1724; that De Moivre said that the problem very likely came originally from one Robins, probably Benjamin Robins,[1] to which opinion Stevens agreed; and that De Moivre had a rather poor opinion of Stevens at that time. The Lord Stanhope mentioned as having been tutored by Robins was doubtless Philip Dormer Stanhope, fourth Earl of Chesterfield, the well-known author of Chesterfield's letters, whose education was chiefly received through private instructors.

The reference in the letter to having worked out some of his best solutions "in my anger," might better, no doubt, have read "in my cups." The Captain Seguin, referred to in the post scriptum, is not mentioned in the standard works on biography. The "32 Sheets compleat" may refer to the revision of the *Doctrine of Chances,* already under way, or possibly to the *Miscellanea Analytica.* Books were not written in a hurry in those days.

The story, so often told, that De Moivre decided to sleep fifteen minutes longer each night, until finally he never awoke, is probably based upon some pleasantry of his in connection with his disease of somnolence which finally ended a life that had become quite unendurable, even with the help of such libations as were then poured out so freely.[2]

QUESTIONS AND DISCUSSIONS.

EDITED BY C. F. GUMMER, Queen's University, Kingston, Ont., Canada.

DISCUSSIONS.

The discussions which follow give cause for special satisfaction in that two of them are in some sense replies to previous papers, while the third closes with a question inviting further investigation. It would seem, from such indications, that this department is at times answering its purpose as a department of discussion.

The letter of Brigadier General Bixby, though it arises out of Professor Candy's article on mechanical solution of equations, is concerned more specifically with graphical solution, and emphasizes in a suitable way the great and increasing importance of this problem. In particular, the writer argues, from his experience, the advantages of Lill's graphical method, and recalls his own attempt in 1879 to make this method known to English reading students, by means of a pamphlet.

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[1] Born at Bath in 1707; died at Fort St. David, Madras, in 1751; author of *Mathematical Tracts,* printed posthumously in 1761.

[2] I am indebted to Mr. Jekuthial Ginsburg for assistance in tracking down some of the facts in connection with this interesting letter.

On account of the great simplicity and utility of the method, and of its almost universal omission from texts in English, some readers of the MONTHLY will perhaps be glad to find a portion of General Bixby's pamphlet quoted at length.

The note by Professor Underwood completes the author's previous work (*1921*, 374–376), and bears some relation to his reply to Question **36** (*1922*, 255).

Professor Mathews proves directly a theorem regarding concyclic sets of points on an equilateral hyperbola which is the inverse of a theorem already known on a bicircular quartic.[1] If, in the notation of the paper, the points $\{B\}$ and $\{C\}$ are kept fixed, the sixteen circles AB_iC_jD through a point A define sixteen transformations of A into D. The question raised at the end of the paper is then how to determine the eight points $\{B\}$ and $\{C\}$ so that the transformations generate a finite group.

I. GRAPHICAL SOLUTION OF NUMERICAL EQUATIONS.[2]

By W. H. BIXBY, Washington, D. C.

I was much interested in the article of Professor A. L. Candy on mechanical solution of equations of the nth degree in a single variable.[3] Theoretically, the method is excellent; but practically there will be much difficulty in using it. It will be difficult to determine or secure the exactitude of the right-angles concerned, and the necessary length of the main bar may be awkward. The most perfect and practical mechanism for such equations is the multiple weighing machine, which has several graduated bars and sliding weights, the final weight indicating a root at each place where the machine balances. It would be costly, but no more so than the modern refined planimeters.

From my own personal experience in such matters, the method of Mr. Lill, Austrian engineer, developed by him about 1867 and exhibited by him at the Vienna World Exposition a little later, is the best graphical method yet developed, and far easier, quicker, and more exact, than any other graphical or mechanical method. I read of this about 1878, and published it in 1879 by a privately printed pamphlet.[4] At that date I had not seen Lill's 1867 printed article.[5] A few months ago I found that Luigi Cremona had also described Lill's method and made it public to English readers in 1888.[6] My pamphlet failed to attract much attention. A few engineers showed some interest in it; but appar-

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[1] R. Lachlan, "On a theorem relating to bicircular quartics and twisted cubics," *Proceedings of the London Mathematical Society*, vol. 21, 1890, pp. 274–280; J. L. Coolidge, *A Treatise on the Circle and the Sphere*, Oxford, 1915, p. 217.

[2] Extract from a letter to the editors.

[3] A. L. Candy, "A Mechanism for the Solution of an Equation of the nth Degree," this MONTHLY, *1920*, 195–199.

[4] W. H. Bixby, *Graphical Method for Finding the Real Roots of Numerical Equations of Any Degree if Containing but One Variable*, West Point, 1879.

[5] M. E. Lill, "Résolution graphique des équations numériques d'un degré quelconque à une inconnue," *Nouvelles Annales de Mathématiques*, series 2, vol. 6, 1867, p. 359.

[6] L. Cremona, *Graphical Statics*, translated by T. H. Beare, Oxford, 1890, pp. 70–76. [More recent accounts of the method are found in C. Runge, *Graphical Methods* (Columbia University Lectures, 1909–1910), New York, 1912, pp. 11–12, and *Praxis der Gleichungen*, Berlin and Leipzig, 1921, pp. 101–110. See also this MONTHLY, *1911*, 159–162—EDITOR.]